to the frame **24** (which may be part of the housing **22** or module **18** and is not shown in FIG. **8A** or **8B**). The Braille dot **20**, is just a dimple in the top surface **46**. Referring now to FIG. **8B**, the MEMS microvalve **284***a* is now closed blocking the flow of pressurized air from the plenum **32** and the MEMS microvalve **284***b* is now opened allowing the air to evacuate from the chamber **30** to the vent **33**. With the pressure vented, the Braille dot **20** contracts, flattening out the dimple on the top surface **46**. The voltage to the two the MEMS microvalves **284***a*, **284***b* are controlled either directly by the microcontroller **40** or by the module microcontroller **45** to extend and retract Braille dots **20** independent of other Braille dots **20**.

FIGS. **9** and **10** show directly actuated devices using shape memory alloy or piezoelectric based devices. FIG. **9** is a design for a microelectromechanical device that directly actuates a Braille dot using a thin film shape memory alloy or piezoelectric element to form the Braille dot **20**. In FIGS. **9A** and **9B**, there is shown a detailed view of a Braille dot **24**) and MEMS device **16** which uses either a thin film shape memory alloy or piezoelectric element **282** as the actuator. A thin film SMA based microelectromechanical actuator is significantly different than traditional bulk shape memory alloy actuators in size, fabrication techniques, and operation. The mechanical properties of a thin film SMA can be precisely tailored by changing the alloy ratios during fabrication while a macro sized bulk SMA actuator may have regions where the alloy ratio changes within the bulk material of the actuator, these regions will increase power consumption, reduce fatigue resistance and limit life. Thin film SMA actuators have greater fatigue life and improved phase transition characteristics then traditional bulk SMA actuators. The thin film SMA also has faster response and lower power consumption than traditional bulk SMA actuators due to their reduced volume and large surface area which allows the actuator to change from one phase state to another faster than the larger bulk SMA actuators. The rapid response of the thin-film SMA actuators allows a user to quickly scroll through a document without having the refreshable Braille display lag behind. The lower power consumption of a thin film SMA actuator reduces the amount of heat that needs to be dissipated from the actuators during operation and can permit battery operation for use with portable electronic devices. Shape Memory Alloys (SMA's) are a unique class of alloys which have the ability to form two different crystalline phases, defined as martensite and austenite, in response to temperature and strain. SMA's are produced by equiatomically combining at least two component metals into a desired shape, which is then annealed. When produced, the SMA is in the austenite phase, having a certain shape and characterized by low ductility, high Young's modulus and high yield stress. Upon cooling the SMA changes to the martensite phase characterized by high ductility, a low Young's modulus and low yield stress. In the martensite phase, the SMA is easily deformed and can take on a different shape from its austenite or original shape by applying an external strain. The SMA will retain this different shape until it is heated to its austenitic transformation temperature. When the SMA is heated to its austenitic transformation temperature the SMA transitions to its austenite phase and transforms back to its original shape. Similarly, piezoelectric elements **282** can be tailored for the application. FIGS. **9A** and **9B** also show the application of a direct actuation of the Braille dot **20** without the need of a pneumatic or hydraulic force.

If a thin film SMA element **282** is used then in FIG. **9A** the thin film SMA element **282** is in its martensite phase with the Braille dot **20** retracted. Since the martensite phase is characterized by high ductility, low Young's modulus and low yield stress, the thin film SMA element **282** is easily deformed by external stresses like biasing means **283**, shown as a spring in FIG. **10**. When heated to its austenitic transfer temperature, the thin film SMA element **282** transitions from its martensite phase to its austenite phase transforming to its austenitic or original shape. The force produced by the biasing means **283** is less than the force produced by the thin film SMA element **282** during this transformation. The thin film SMA element **282**, thereby, overcomes that force during this transformation, and, in so doing, extends the Braille dot **20** as shown in FIG. **9B**. The thin film SMA element **282** is heated by joule heating using electric current from an electric power source controlled by the microcontroller **40** (not shown in FIG. **9A** or **9B**). Because the austenite phase is characterized by low ductility, high Young's modulus and high yield stress, the thin film SMA element **282** remains in its austenitic or original shape and the Braille dot **20** remains extended. When the electric current is removed, the thin film SMA element **282** cools to its martensitic transfer temperature at which point it transitions to the martensite phase and the external stress from the biasing means **283** deforms the thin film SMA element **282**, retracting the Braille dot **20**. Alternately, the thin film SMA element **282** can be operably connected to the Braille dot **20** to retract it when transitioning from its martensite phase to its austenite phase. The Braille dot **20**, then, will be extended by the biasing means **283**, when the thin film SMA element **282** transitions from the austenite phase to the martensite phase. The Braille dot **20** is extended and retracted based upon the crystalline phase of the thin film SMA element **282**. Instead of a spring as shown, the biasing means **283** can be any mechanism including a second thin film SMA element, a diaphragm or manipulated boss. Again, similarly a piezoelectric element **282** can be used so when a electric field is applied the thin film expands resulting in a similar movement of the element **282**.

In FIGS. **10A** and **10B**, the thin film SMA or piezoelectric element is shown directly forming the Braille dot itself **282**. The Braille dot may be covered with a polymer cover **20** which can provide a biasing force to flatten the Braille dot. The biasing force may be provided by either a pressure or a vacuum applied through the orifice located directly under the SMA film **282**. Similarly direct actuation of the Braille dot **20** can be accomplished with a MEMS device **16** utilizing other mechanisms not based on shape memory alloy like springs, diaphragms and bosses. It is only necessary to have opposite biasing forces operably attached to the Braille dot **20** in a manner such that the Braille dot **20** can be extended and retracted in response to signals from the microcontroller **40** or module microcontrollers **45**.

In another embodiment shown in FIG. **11**, the present invention includes an electrostatic microelectromechanical valve having a structure with an open and a closed position comprising an inlet port **301**; a base plate **302** containing an electrode **303**; and a closure diaphragm **304** containing an electrode **305** wherein the diaphragm **304** with a boss **306** for closing the inlet port **301** and at least two radial beams **307** to connect the boss **306** to the main microelectromechanical valve structure. FIG. **11A** shows an open valve, FIG. **11B** shows a closed valve and FIG. **11C** shows the diaphragm from above. Preferably, the boss of the diaphragm is connected to the main microelectromechanical valve structure by at least four beams **307**, and more preferably by at least eight beams **307**. In FIGS. **12** A, B, C, D, E, F, G, and H, various electrostatic microelectrome-